Vector Research, Incorporated

Examining Artillery System Capabilities with the Animated Cannon Battalion Simulation (ACBS)

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Purpose

To demonstrate the Animated Cannon Battalion Simulation (ACBS)

Agenda

ACBS Overview

ACBS Components

ACBS Model Logic

Model Demonstration

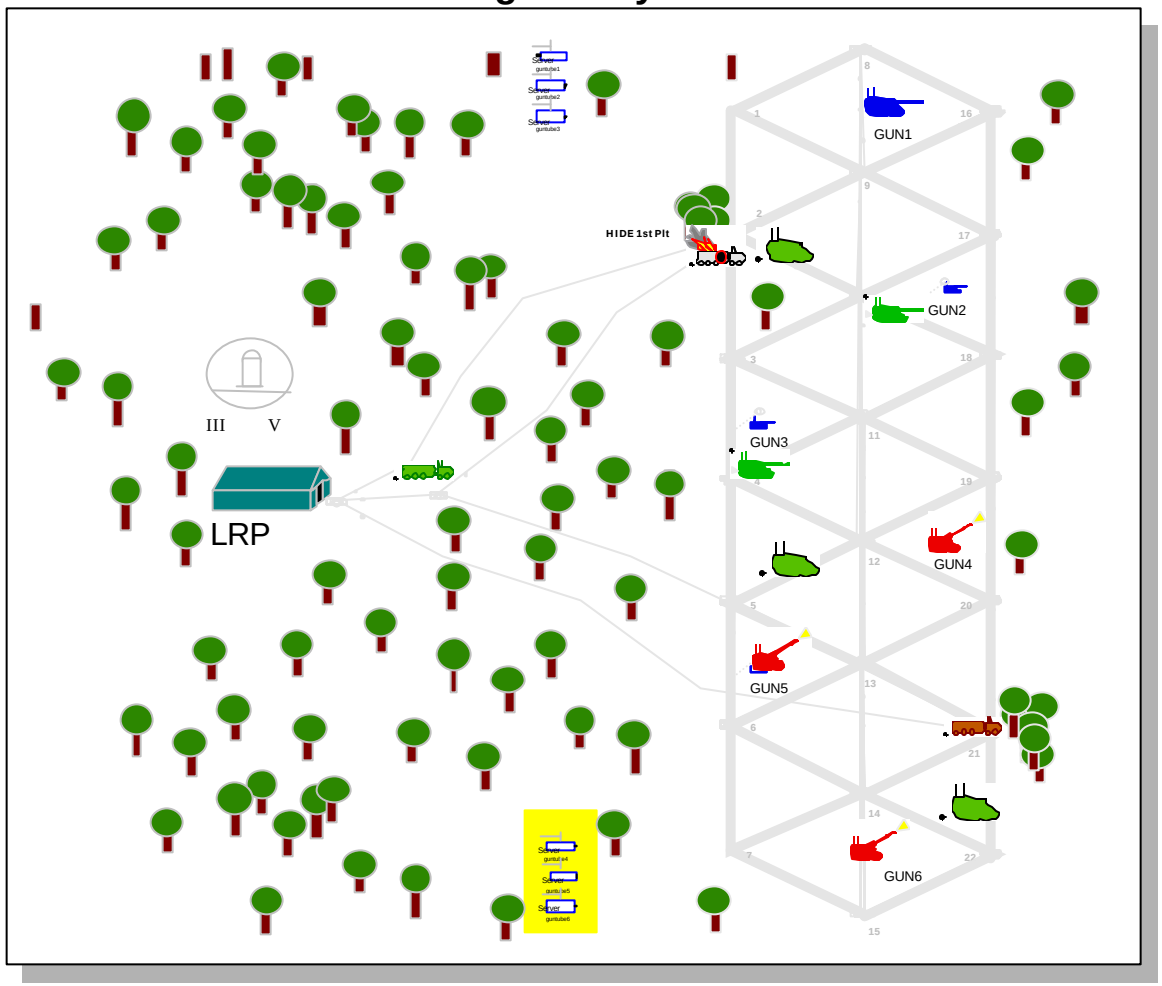
Example Analysis

Summary

ACBS Overview

The Animated Cannon Battalion Simulation (ACBS) is a discrete event, stochastic simulation developed in Arena, a graphical simulation package

ACBS Firing Battery Animation



Prior Studies using ACBS:

- Resupply Operations Studies
- Thermal Load Analysis
- Reliability Studies
- MACS Analysis
- Communication Studies

VECTOR-3 Inputs Derived from ACBS:

- Resupply
- Rate of Fire
- Availability
- Supportability
- Vulnerability

— Continued —

ACBS Overview

Model Purpose: Examine and evaluate alternate cannon operations and capabilities

Processes Simulated

- Ammunition selection
- Assignment of missions to guns
- Firing
- Tactical and survivability moves
- System reliability
- Thermal load
- Variable combat intensity
- Resupply

— Continued —

ACBS Overview (Concluded)

Example Inputs

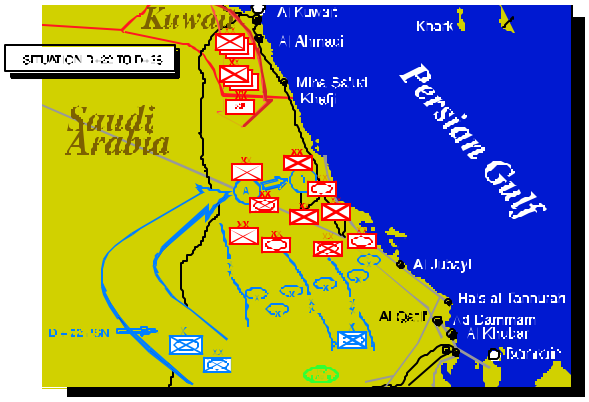
Ammunition basic load
RAM data
Vehicle mobility
Resupply strategies
Hook-up and resupply times
Travel distances
Gun-to-target range distribution
Vehicle capacities
Target type and distribution
Target arrival rates
Attrition rates

Example Outputs

Number of missions fired
Number of missions not fired and reason
Utilization rates
Total munitions fired by type
Average rates of fire
Average throughput

Development of VECTOR-3 Inputs

Resupply values
Rate of fire
Availability
Supportability
Vulnerability



ACBS Components

ACBS consists of two components: User Interface and Model Logic

User Interface–Excel

Input Variables

The interface consists of two parts: initialize sheet and data sheets.

Excel organizes and displays the input data.

The user selects system types and ACBS parameters.

Excel Visual Basic macros convert spreadsheet data into text files.

In Arena, ACBS "reads" in the text files during model initialization.

Model Logic–Arena

Initialize Variables

Mission Arrival

Platoon and Gun Selection

Counterfire

Munition Assignments (rds)

Guns Main Code
Check Ammo Move Guns

Resupply Guns
Move RSVs

Resupply LRP

Resupply RSVs

Status Check

Balk Counters

MACS Calculations

Pre-Fire Checks

Mission Counters

Reliability

Thermal Calculations

The model logic flows in accordance to fire mission processing:

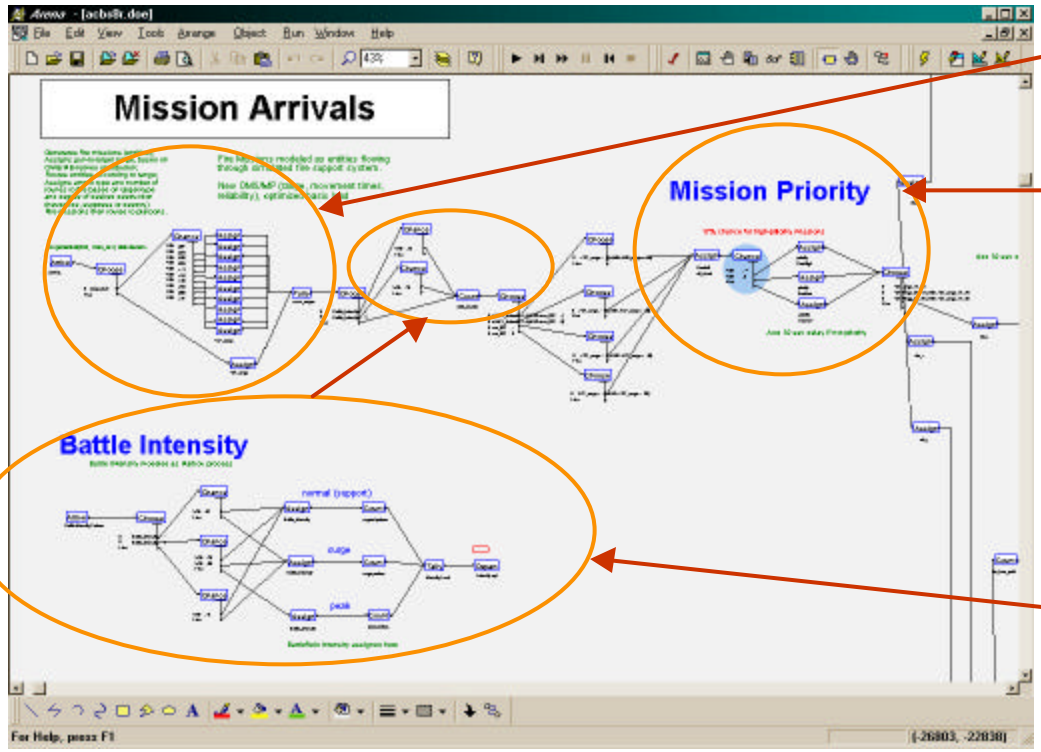
1. Receive mission.
2. Determine priority, ammo, and who to fire.
3. Verify ammo and operational status.
4. Fire the mission.
5. Resupply as necessary.
6. Information Management.

Animation of a Firing Battery

Note:
- Yellow areas indicate the sections that were redesigned.
- All sections, or "views," are displayed in relation in how they appear in Arena.

ACBS Model Logic
Fire Mission Arrivals

ACBS begins with the arrival of a fire mission (FM). All FMs arrive at the battalion Fire Direction Center (FDC) and are sent to a firing battery.



The arriving entity represents a FM. Attributes describe its characteristics.

There are three FM priorities: High, Medium, and Low. An index is used to prioritize the release entities in queues:

-1. Move from hide position to firing point
1. High priority mission (red ball)
2. Movement order (green ball)
3. Medium priority FM (red ball)
4. Low priority FM (red ball)

Battle intensity is defined by surge, peak, and support periods. This controls the flow of FMs into ACBS.

The following are the attributes of a FM:

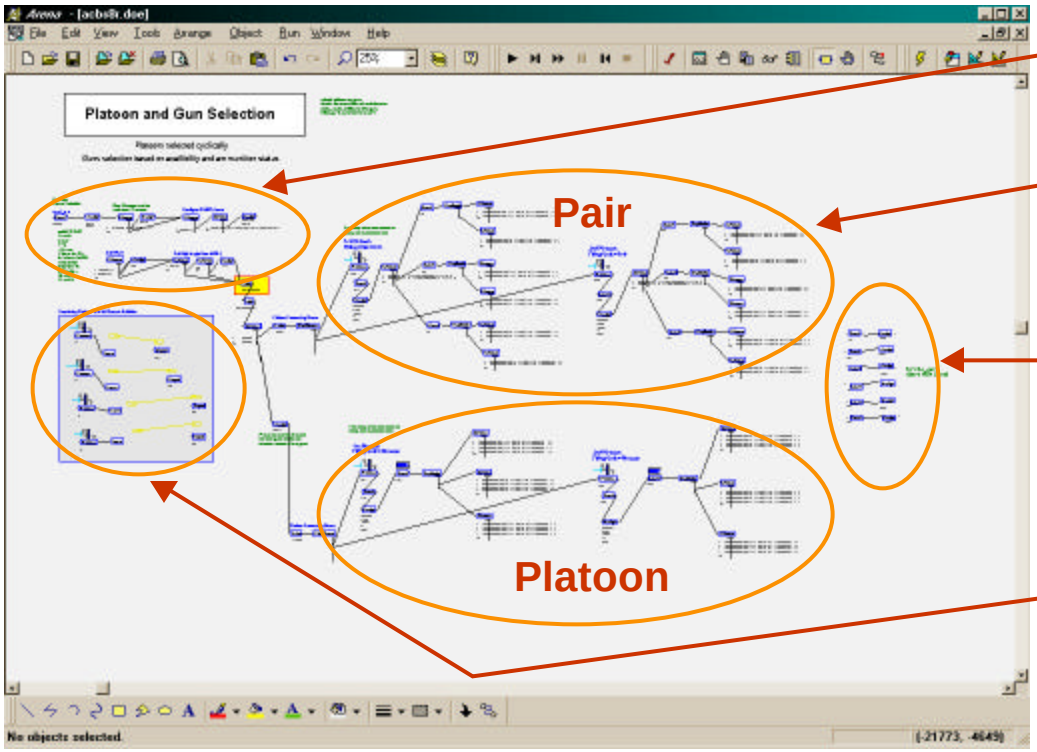
- Gun-target (GT) range
- Type (hard or soft, high angle, MRSI)
- Size (point or area)

The FM attributes will be used to determine the type and number of rounds to fire.

Entity moves to Munition Assignment

ACBS Model Logic
Platoon and Gun Selection

What and where to fire has been determined. Now, who will fire must be determined.



Depending on the fire mission, high angle or MRSI fires are determined here.

Three guns (platoon) or two guns (pair) may fire the mission. This control measure was selected in the User Interface.

The entity is duplicated for each gun that is selected to fire the mission. The corresponding "gun number" is assigned to the entity (as an attribute).

Not all FMs generated goes to the animated firing battery in ACBS. The other missions are sent to the other "ghost" platoons in the artillery battalion.

The attribute "gun_no" is the key for indexing for gun ammunition, movement of gun transporters, and resupply actions.

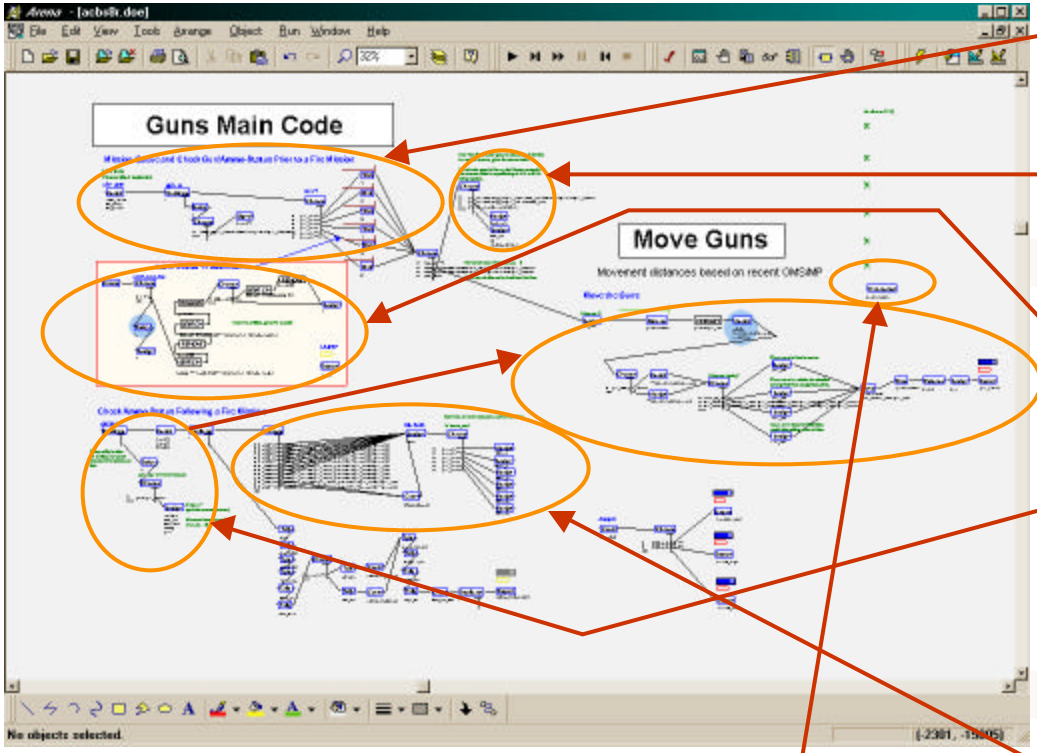
NOTE

The movement of guns and RSVs is animated and controlled by Arena transporters.

Entity moves to Guns Main Code

ACBS Model Logic
Gun's Main Code

The gun's main code prioritizes missions, moves the gun, clears stale missions from the gun queues, and generates resupply actions.



Given the "priority" attribute, the WAIT module priorities missions and releases them based on "LowValueFirst."

If the entity has a priority attribute that refers to a FM, the number of MACS will be assigned.

Entity moves to MACS Calculations

Stale missions are removed. Movement orders are never removed. One entity is created and never leaves this group of modules.

After firing all required rounds of a FM, a movement order is generated (green ball). This is the only section in ACBS where the gun is moved. The gun is moved to an alternate firing position, the hide, or to its initial firing position.

Entity moves to Move Guns

Gun transporters are defined. Only gun velocity is used with the transporters. The transporter has three states: idle/ready, busy, and inactive. Transporters are controlled by the ALLOCATE module, because the entity tells the transporter to move to a specific station; the entity itself does not move to the station.

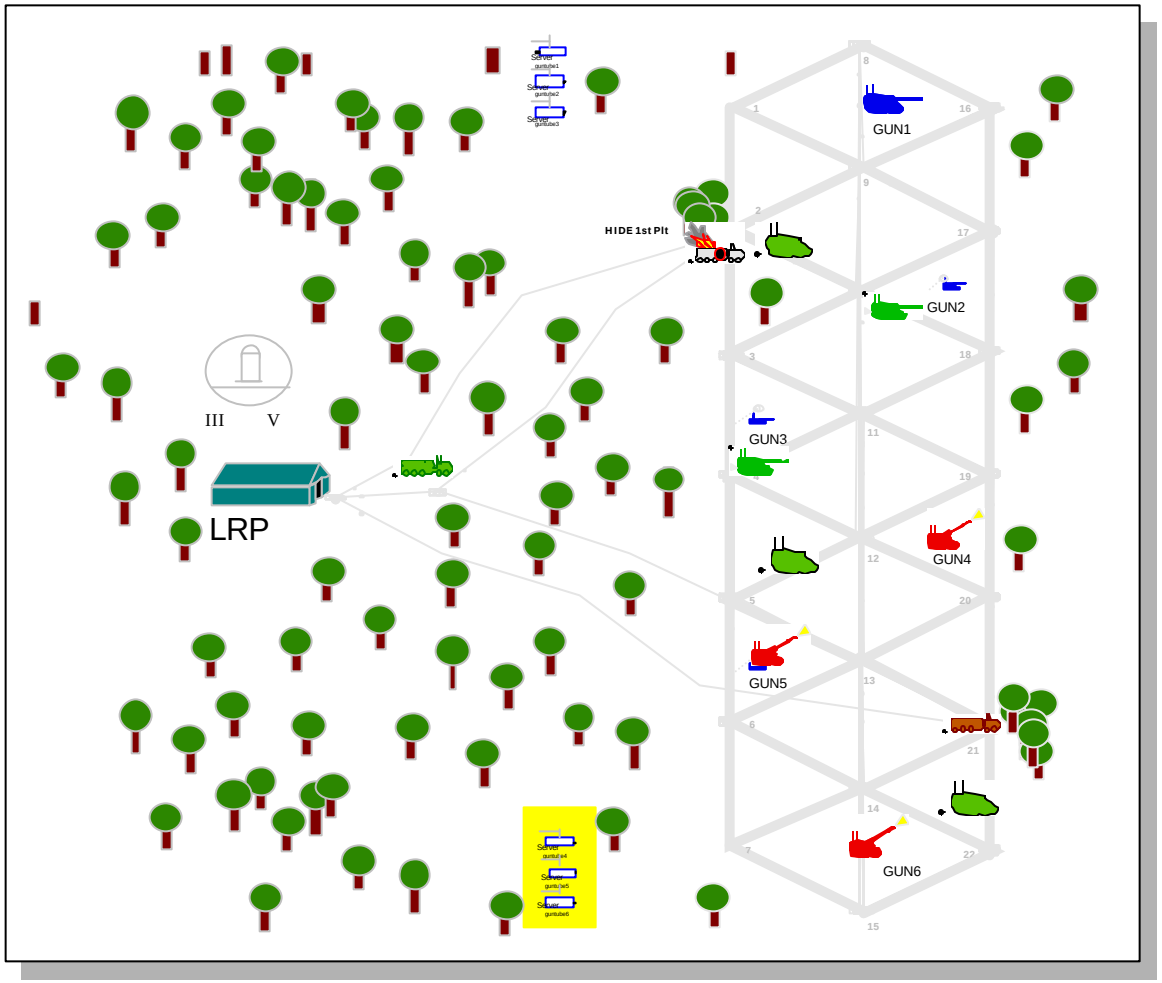
Based on critical ammunition identifiers and resupply thresholds, ammunition resupply requests are generated.

Entity moves to Resupply Guns

NOTE Movement orders are defined with the attribute of NUM_rds, which is equal to zero (0).

Model Demonstration

ACBS Firing Battery Animation



Example Analysis
Thermal Load Problem

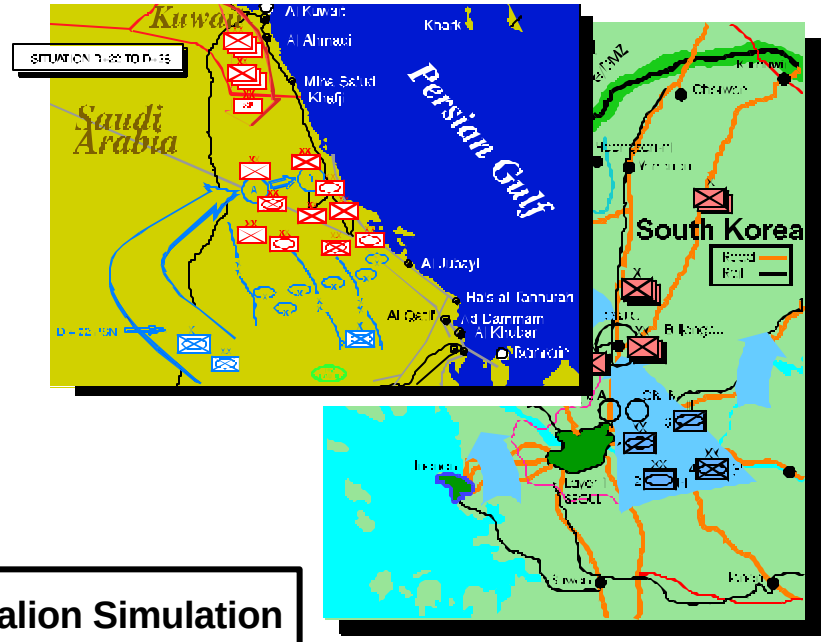
Determine the system and force effectiveness impacts of Crusader gun tube and recoil mechanism thermal constraints.

Example Analysis
Methodology

Two-Level Assessment

2 **Assess Impact Upon Force Effectiveness**

Represent volume of fire differences in a corps-level warfight

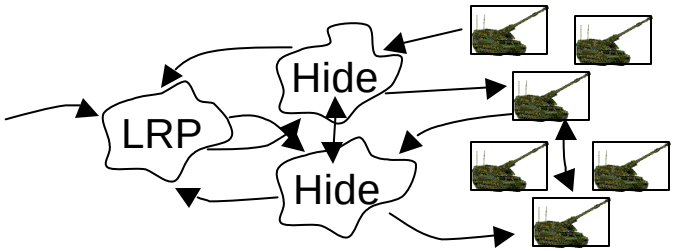


1 **Assess Impact of Thermal Load Constraint upon Volume of Fire**

RSV (T)

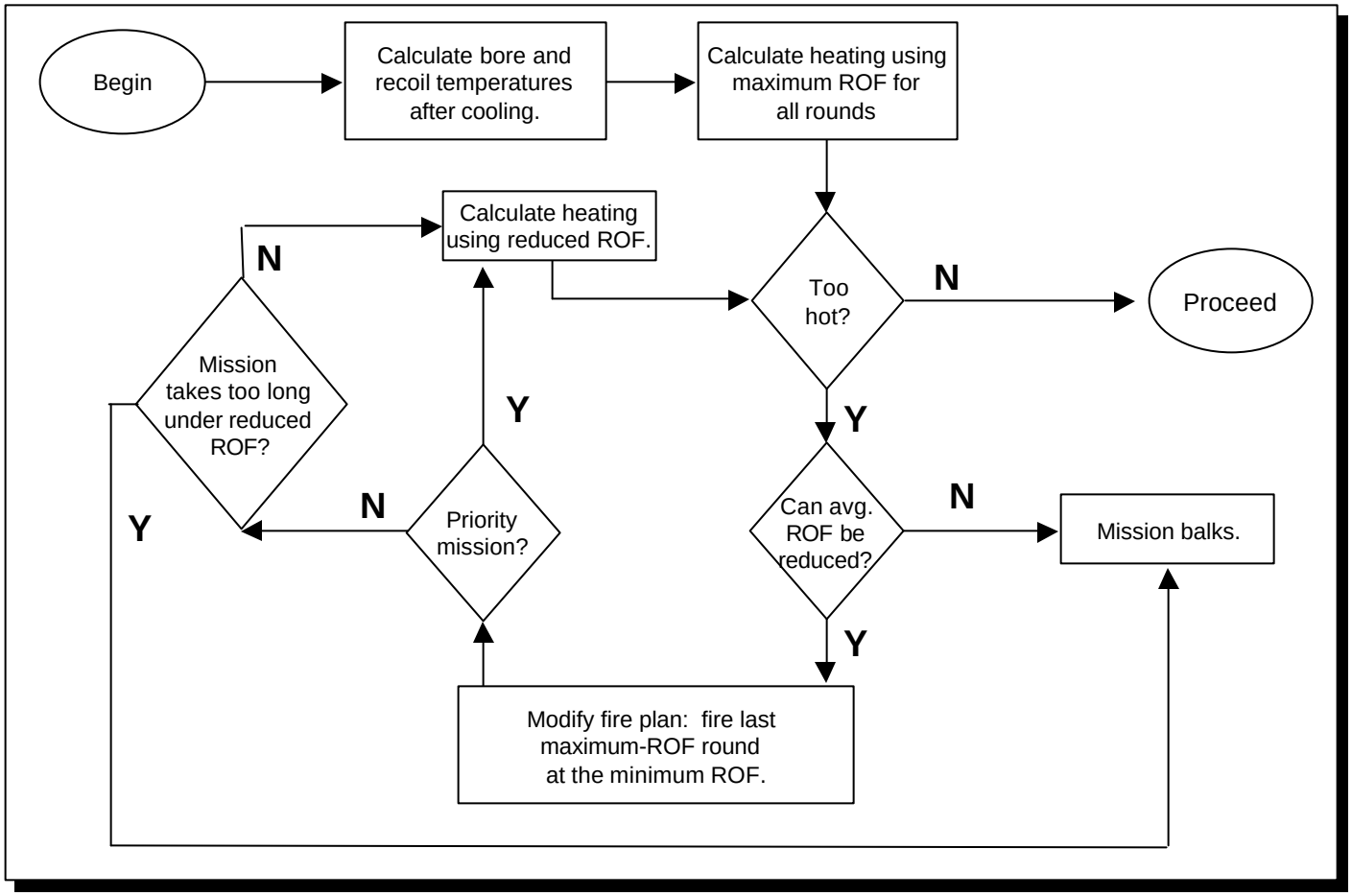
SPH

Animated Cannon Battalion Simulation



Bottom-Up Approach

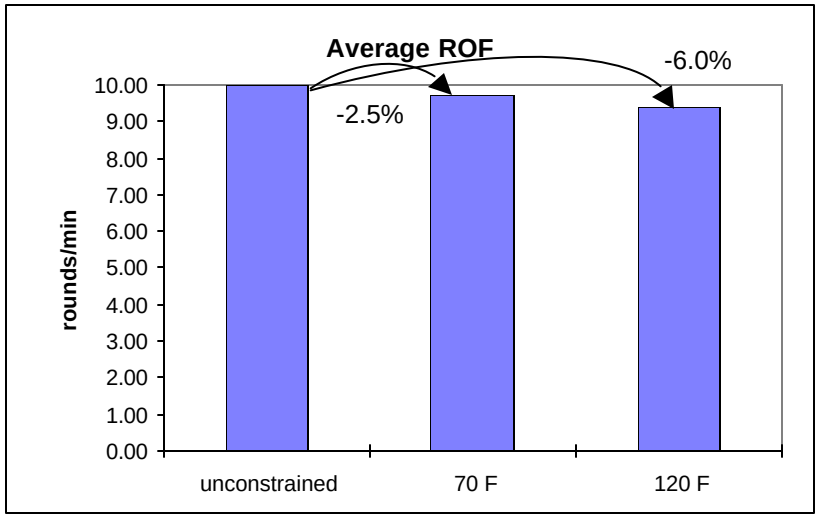
Example Analysis
Thermal Constraint Firing Algorithm

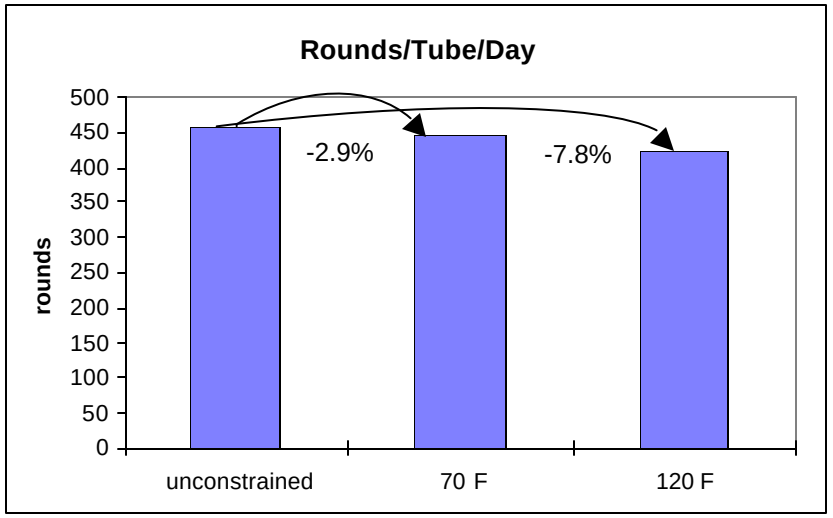


Firing algorithm used to determine ROF for the Crusader thermal load analysis.

Example Analysis
ACBS Results

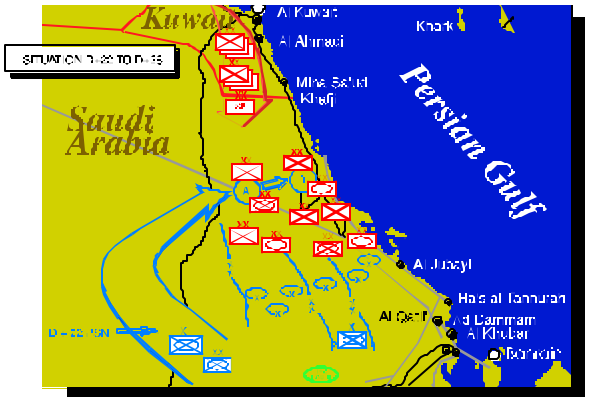
50 replications for each case: unconstrained, 70°F, 120°F ambient temperature

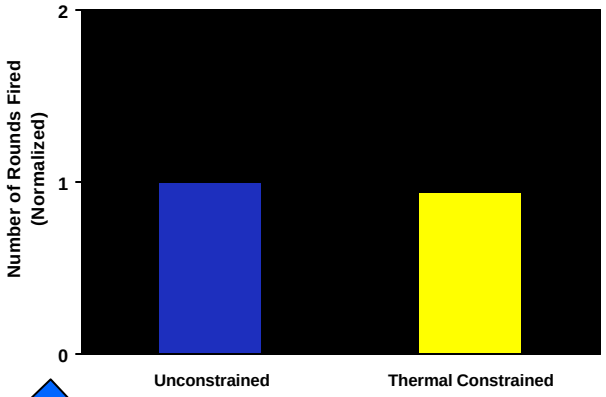




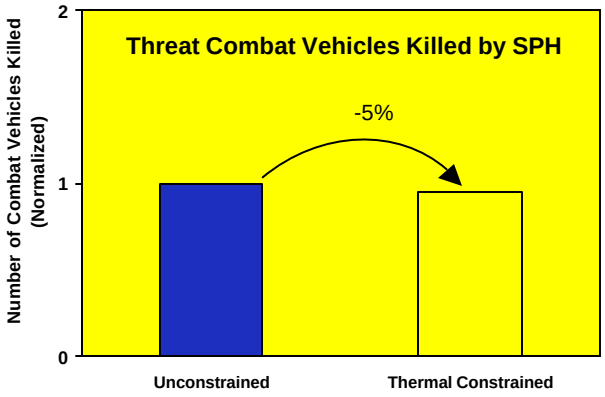
- Average ROF is a function of thermal availability
- Reduced thermal availability translates to reduced average rates of fire and system volume of fire
- Thermal effects on rate of fire and cannon availability are represented in the Force-on-Force analysis

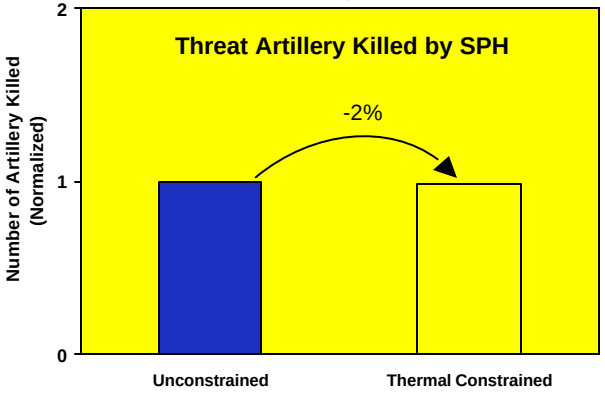
Example Analysis
SWA Force-on-Force Results

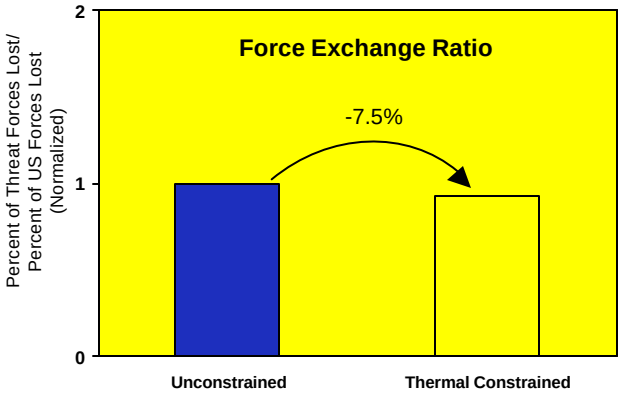




To capture cannon artillery warfighting contributions, you must represent the thermal burden.







The ACBS model helped VRI accurately account for the cooling capabilities of the Crusader cannon system in a force-on-force model.

ACBS Summary

ACBS is a high-resolution model that can be used to examine the impact of cannon artillery system capabilities upon system performance.

The ACBS User Interface allows the analyst to study alternative artillery systems and capabilities without modifying model logic.

Model animation enables the analyst and user to visualize the impact of system capabilities and procedures upon unit operations.

System effectiveness measures captured from ACBS results can be used as inputs to theater-level, force-on-force models.